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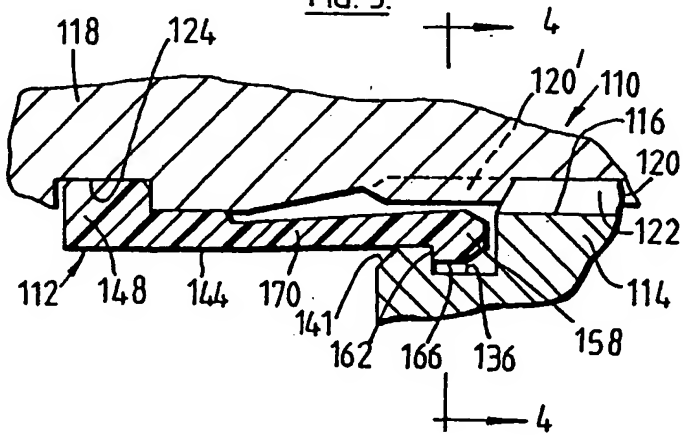
(54) Axial retaining member

(57) Axial retaining member (112) preferably a unitary thermoplastics moulding, for locking e.g. a splined shaft (118) into a splined bore of a female member (114) such as an inner race of a constant velocity universal joint, has a cylindrical body (144) and, at one end, an inwardly projecting flange (148) locating in a channel in the shaft, and, at the other end, an outwardly projecting flange (158) locating in a channel in the bore of the female member. The body (144) has a longitudinally extending region of reduced radial thickness to enable the retaining member (112) to open during assembly over the shaft (118).

FIG. 3.



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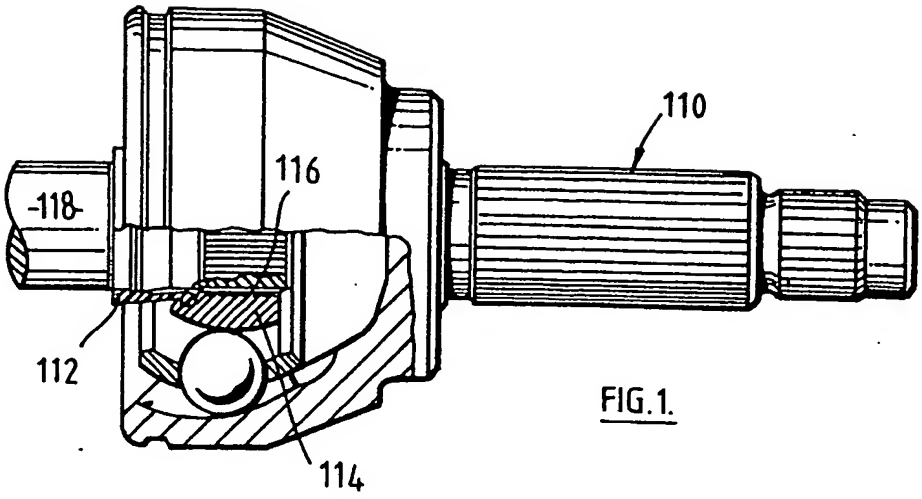


FIG.1.

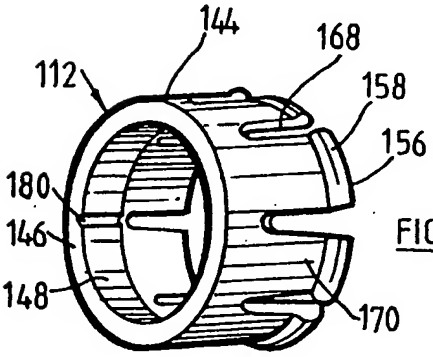
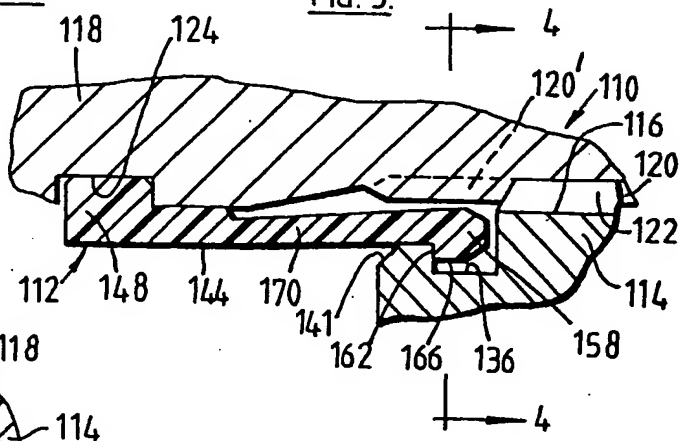


FIG.2.

FIG. 3.



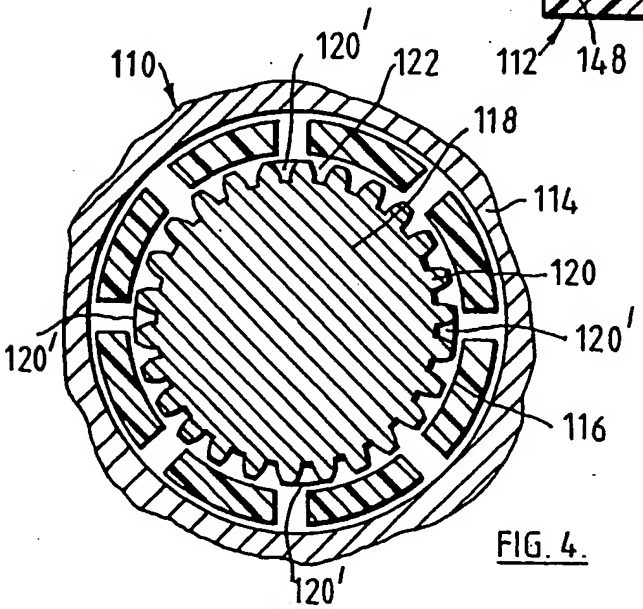


FIG. 4.

SPECIFICATION

Torque-transmitting joint assembly

The present invention relates in one aspect to a torque-transmitting joint assembly with an axial retaining member for retaining two components together which are separable by relative movement along an axis, and in another aspect to a torque-transmitting joint assembly comprising a shaft and a shaft-receiving member with cooperating splines. The present invention is particularly useful for preventing relative axial motion between a female member, such as an inner race of a constant velocity universal joint of a half-shaft assembly, and a shaft inserted in a bore in the female member.

It is known from GB-A-2145148 to provide such an axial retaining member in the form of an axially-extending annular collet of resilient material having an inwardly projecting flange at one end for location in an annular groove in the shaft. The other end of the collet has an outwardly projecting flange for connection with the bore in the female member. The collet is assembled onto the shaft by pushing it axially from one end of the shaft, the collet resiliently deforming temporarily to a larger diameter as a result of pressure on the inwardly projecting flange, which then snaps into position in the annular groove.

The necessary degree of resilience limits the choice of materials for the collet, and precludes the use of fairly rigid materials such as thermoplastics which are strongly resistant to failure as a result of deformation during assembly or during the operating life of the universal joint. It is an object of the invention to provide an axial retaining member of the type described above but capable of being formed of a harder, more dimensionally stable and more impact-resistant thermoplastics material than has been used hitherto.

Accordingly, the invention, in one aspect, provides a torque-transmitting joint assembly comprising a shaft connected to a female, shaft-receiving member such that relative rotation is prevented, the shaft and shaft-receiving member being separable by relative axial movement and retained against such axial movement by an axial retaining member, said retaining member being formed of a resilient material and comprising a main body extending longitudinally of said axis and having a first end, a second end, and a central passageway through said main body along said axis; first connection means extending radially inwardly from said main body, disposed at or adjacent said first end thereof and engaged in a recess in one of said shaft and shaft-receiving member; and second connection means extending radially outwardly from said main body, disposed at or adjacent said second end thereof and engaged in a recess in the other of said shaft and shaft-receiving member; a plurality of longitudinal slots being formed in said main body and extending from said second end towards the first end such as to separate said second end into a plurality of longitudinally extending flexible fingers, supporting said second connection means; characterised in that the main body is formed with a region of reduced radial thickness which region extends longitudinally from the first end and across said first connection means to permit a controlled separation of at least a portion of said main body at the said region.

The controlled separation of at least a portion of the main body allows the axial retaining member temporarily to increase its internal diameter at the first connection means, for assembly over the corresponding component, without requiring the axial retaining member to have a great resilient deformability tangentially. This enables the axial retaining member to be formed of harder, less deformable, more impact-resistant material, such as thermoplastics.

Advantageously, the said region of reduced thickness extends to meet one of the said longitudinal slots, so that the controlled separation occurs along the full length of the axial retaining member.

Preferably, the shaft is so thick that it prevents disengagement of the second connection means from the recess in the said other of the shaft and shaft-receiving member by resisting radial inwards deformation of the second end of the axial retaining member. This allows the shaft to be substantially stronger than if provision were required to allow such inwards radial deformation, but of course the axial retaining member must be assembled onto the shaft-receiving member before insertion of the shaft takes place.

The invention also provides a method of making such an assembly, comprising fitting said axial retaining member into the shaft-receiving member, engaging said second connection means of the axial retaining member in said recess therein, and then fitting said shaft into the axial retaining member and shaft-receiving member causing the said portion of said main body to separate at said region, and engaging said first connection means in said recess in the shaft.

According to a further aspect, the invention provides a torque-transmitting joint assembly comprising a splined shaft and a female, shaft-receiving member splined internally so as to complement and cooperate with the splined shaft, characterised in that at least one groove between adjacent splines of the shaft or of the shaft-receiving member is blocked at a point intermediate the axial ends of the splined region thereof, the others of the splines being unblocked at that axial point, to limit relative axial movement of the shaft and shaft-receiving member. Where an axial retaining member is used in the joint assembly as described above in relation to the first aspect of the invention, the blocking of the spline or splines prevents damage to the axial retaining member as a result of impulsive axial forces during assembly.

In order that the invention may be better understood, a preferred embodiment thereof will now be described, by way of example only, with reference to the accompanying drawings, of which:-

Figure 1 is a partially cut away side view of a half-shaft assembly, shown fragmentarily, with a constant velocity universal joint that uses an axial retaining member embodying the present invention;

Figure 2 is a perspective view of an axial retaining

member embodying the present invention;

Figure 3 is a view, to an enlarged scale, of a portion of the assembly of Figure 1 and illustrating the axial retaining member of Figure 2; and

Figure 4 is a sectional view taken on line 4-4 of Figure 3.

Referring now to Figure 1, a half-shaft assembly shown fragmentarily incorporates a universal joint of the constant velocity type 110 and has an axial retaining member 112 embodying the present invention. The universal joint 110, in general, is well known and, accordingly, the many individual components thereof are not described in detail herein. Furthermore, it will be understood by those skilled in the art that the present invention, while illustrated in relation to a universal joint assembly, has applicability for interconnecting various members. The axial retaining member is particularly well suited for interconnecting splined shafts and splined male members, to prevent relative axial movement therebetween, but may be used for other more diverse interconnection functions.

The universal joint 110 includes an inner race 114 having a bore 116 therein. A shaft 118 is fitted in the bore 116 and is prevented from rotating relative thereto by mating splines 120 and 122 (Figure 3) extending, respectively, from the shaft 118 and from the inner race 114. The axial retaining member 112 is provided to inhibit axial movement of the shaft 118 relative to the inner race 114 and further to facilitate rapid assembly of the universal joint assembly 110.

As illustrated in Figure 3, the shaft 118 is provided with an outwardly oriented annular channel 124 having a base and annular walls and extending from the base to an outer peripheral cylindrical surface of the shaft 118. The annular walls form abutments for retaining the shaft against motion relative to the inner race 114.

The inner race 114 is provided with a counterbore coaxial with the bore 116 and an inwardly oriented annular channel 136 extending around the counterbore and opening radially into the counterbore. As indicated in Figure 3, the inwardly oriented annular channel 136 has a base portion and two annular walls each extending from the base portion of the channel towards the shaft 118. A frustoconical sloping surface 41 is provided adjacent the counterbore and slopes inwardly towards the counterbore.

The axial retaining member 112 takes the place of both the spacer ring and the retainer ring previously used in universal joint assemblies and further facilitates the assembly of the universal joint 110. The axial retaining member 112 includes an elongate member having a main body portion 144, as best shown in Figure 2. The main body portion 144 is formed of resilient material and has, in general, a cylindrical shape or a similar hollow form of revolution. The main body portion 144 has a first end 146 having an inwardly oriented radial flange 148 formed therein or adjacent thereto. The inwardly oriented radial flange 148 has a cylindrical base wall and an outer and inner annular wall, extending generally perpendicular to the cylindrical base wall. As shown in Figure 3, the main body portion 144 of the axial retaining member 112 may be fitted rotatably onto the shaft 118 with the inwardly oriented radial flange 148 fitted into the outwardly oriented annular channel 124.

The axial retaining member 112, as shown in Figure 2, is provided with a second end 156 opposite the first end 146. An outwardly oriented radial flange 158 is provided at or adjacent to the second end 156, for rotatable engagement in the annular channel 136 of the inner race. The outwardly oriented radial flange 158 is provided with a frustoconical surface having an increasing diameter in the direction extending from the second end 156 towards the first end 146 of the axial retaining member 112. The outwardly oriented radial flange 158 is further provided with an annular surface 162 extending generally perpendicular to the main body portion 144 and extending between an outer cylindrical surface of the main body portion 144 of the axial retaining member 112 and the frustoconical surface by way of an intermediate cylindrical surface 166.

The axial retaining member 112 is further provided with a plurality of longitudinal slots 168 extending from the second end 156 thereof partially towards the first end 146 thereof. The longitudinal slots 168 divide the second end 156 of the axial retaining member 112 into a plurality of flexible fingers 170. The longitudinal slots further divide the outwardly oriented radial flange 158 into a plurality of independent flange portions. In the example shown in Figure 2, eight longitudinal slots 168 are provided and, accordingly, eight flexible fingers 170 are provided.

The first end 146 of the axial retaining member 112 is provided with a region of substantially reduced thickness that extends along a longitudinally extending line 180, the longitudinally extending line 180 beginning at the first end 146 of the axial retaining member 112 and terminating at one of the plurality of longitudinal slots 168. The reduced thickness of the axial retaining member 112 along the longitudinally extending line 180 gives the axial retaining member an area of weakness which permits the axial retaining member to controllably separate along the longitudinally extending line 180 into a double-ended or C-shaped configuration when the axial retaining member is assembled onto the shaft 118 of a universal joint 110 by inserting the end of the shaft 118 into the axial retaining member 112, after the axial retaining member 112 has been assembled into the base 116 of the inner race 114 of the universal joint 110. The thickness may be reduced to zero, so that the axial retaining member is open even before assembly. Preferably, however, it is reduced to a small fraction of the adjacent thickness, so that the region separates readily.

Thus, the axial retaining member 112 can be applied to the shaft 118 without requiring significant resilient deformation of the axial retaining member 112 in the tangential sense, thus permitting the use of a harder, more dimensionally stable and more impact-resistant thermoplastic material in the manufacture of the axial retaining member 112 than would be the case with respect to an axial retaining member that was not designed to separate into such a C-shaped configuration during assembly. The use of a hard, dimensionally stable, impact-resistant thermo-

plastics material in the manufacture of the axial retaining member 112 is advantageous because it enhances the ability of the axial retaining member to resist failure as a result of deformation under loads of the type that can be encountered during the assembly of the universal joint 110 in an automotive assembly plant, for example, or during the operating life of such a universal joint 110. A glass-impregnated nylon (polyamide) thermoplastics material has been found to be well suited for use in the manufacture of axial retaining members by injection moulding. The axial retaining members conveniently have a unitary form, the main body being integral with the flanges.

The axial retaining member 112, by virtue of its resistance to deformation under load, cannot be removed from the universal joint 110 without physical destruction of the axial retaining member. Thus, the shaft 118 of the universal joint 110 need not incorporate a reduced diameter surface portion to provide a clearance for the removal of the axial retaining member 112 from the shaft 118. Indeed, the shaft 118 is so thick that it prevents disengagement of the outwardly orientated radial flange 158 from the annular channel 136.

In the assembly of the universal joint 110, to be described below, the outwardly extending splines 120 around the end portion of the shaft 118, engage the splines 122 extending inwardly from the bore 116 of the inner race 114 of the universal joint 110. The advancement of the shaft 118 into the inner race 114 is limited by blocking the spaces between certain pairs of the splines 120 on the shaft 118, for example, at four locations 120' located at 90 degree intervals around the shaft. The blocking extends axially from a point intermediate the axial ends of the splined region of the shaft 118. Thus, if the universal joint 110 encounters any substantial axial end loads during assembly or during its operating life, e.g. impulsive axial loads, such end loads will be absorbed by contact between the splines 122 of the bore 116 and the blocked portions of the splines 120 of the shaft 118, which elements are made of steel or other strong metallic material, and such substantial end loads will, therefore, not be imposed on the axial retaining member 112 which is not as well suited to carry such end loads because of its construction from a thermoplastics material. This further ensures that the axial retaining member 112 will not fail during assembly or during the operating life of the universal joint.

Assembly of the constant velocity universal joint 110 will now be described. The axial retaining member 112 is first inserted with a snap fit into the bore 116, the radial flange 158 engaging in the annular channel 136. The shaft 118 is then pushed into the axial retaining member 112 and the bore 116, causing the member 112 to open in a controlled manner at the region of reduced thickness 180. The inwardly orientated flange 148 then snaps into place in the complementary channel 124 in the shaft 118. At the same time, the splines 120, 122 become engaged.

The flexible fingers 170 are preferably proportioned such as to extend in their unstressed condition to an outer diameter larger than the inner diameter of the base portion of the inwardly oriented channel 136. Thus, when the flexible fingers 170 are trapped in the inwardly oriented channel 136, as illustrated in Figure 3, the flexible fingers 170 are resiliently biased outwardly, i.e. are pre-stressed, and contribute to a secure engagement between the axial retaining member 112 and the inner race 114. When the fingers 170 are pre-stressed in this manner, a tool, a retaining clip, or other retaining means may be used to temporarily deflect the flexible fingers 170 to temporarily secure them during assembly.

CLAIMS

1. A torque-transmitting joint assembly comprising a shaft connected to a female, shaft-receiving member such that relative rotation is prevented, the shaft and shaft-receiving member being separable by relative axial movement and retained against such axial movement by an axial retaining member, said retaining member being formed of a resilient material and comprising a main body extending longitudinally of said axis and having a first end, a second end, and a central passageway through said main body along said axis; first connection means extending radially inwardly from said main body, disposed at or adjacent said first end thereof and engaged in a recess in one of said shaft and shaft-receiving member; and second connection means extending radially outwardly from said main body, disposed at or adjacent said second end thereof and engaged in a recess in the other of said shaft and shaft- receiving member; a plurality of longitudinal slots being formed in said main body and extending from said second end towards the first end such as to separate said second end into a plurality of longitudinally extending flexible fingers, supporting said second connection means; characterised in that the main body is formed with a region of reduced radial thickness which region extends longitudinally from the first end and across said first connection means to permit a controlled separation of at least a portion of said main body at the said region.

2. An assembly according to Claim 1, further characterised in that the region of reduced radial thickness extends to meet one of the longitudinal slots.

3. An assembly according to Claim 1 or 2, further characterised in that said flexible fingers are in a pre-stressed condition in use.

4. An assembly according to any preceding claim, further characterised in that the shaft is so thick that it prevents disengagement of the second connection means from the recess in the said other of the shaft and shaft-receiving member by resisting radial inwards deformation of the second end of the axial retaining member.

5. An assembly according to any one of the preceding claims further characterised in that said main body and said first and second connection means are moulded as a single piece of a plastics material.

6. An assembly according to Claim 5, further characterised in that the plastics material is a hard, dimensionally stable, impact resistant thermoplastics material.

7. An assembly according to any one of the preceding claims further characterised in that said first connection means comprises a radially extending flange.

8. An assembly according to any one of the preceding claims further characterised in that said main body is generally cylindrical in shape.

9. An assembly according to any preceding claim, further characterised in that the shaft is splined and extends through said axial retaining member, its recess consisting of an annular channel receiving said first connection means, and the shaft-receiving member has a splined bore receiving and cooperating with the splines of said shaft and having a counterbore with an annular channel, constituting said recess, receiving said second connection means.

10. An assembly according to Claim 9, further characterised in that at least one of the cooperating splines is blocked to permit the assembly to withstand substantial axial end loads without the imposition of substantial axial end loads on the axial retaining member.

11. A method of making an assembly according to any preceding claim, comprising fitting said axial retaining member into the shaft-receiving member, engaging said second connection means of the axial retaining member in said recess therein, and then fitting said shaft into the axial retaining member and shaft-receiving member causing the said portion of said main body to separate at said region, and engaging said first connection means in said recess in the shaft.

12. A torque-transmitting joint assembly comprising a splined shaft and a female, shaft-receiving member splined internally so as to complement and cooperate with the splined shaft, characterised in that at least one groove between adjacent splines of the shaft or of the shaft-receiving member is blocked at a point intermediate the axial ends of the splined region thereof, the others of the splines being unblocked at that axial point, to limit relative axial movement of the shaft and shaft receiving member.

13. An axial retaining member substantially as hereinbefore described with reference to the accompanying drawings.

14. An assembly substantially as hereinbefore described with reference to the accompanying drawings.

15. A method of making an assembly, substantially as hereinbefore described with reference to the accompanying drawings.

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